Accuracy assessment of National Wetland Inventory maps at Sequoia and Kings Canyon National Parks

By Harold W. Werner

Introduction

Both long-term planning and daily management of wetlands require knowledge of where wetlands exist and their vulnerabilities. For example, uncontrolled visitor use or poorly located facilities can damage wetlands, many of which, like marshes, are obvious, but identifying other types of wetlands requires technical skills. The National Park Service's policy of "no net loss of wetlands" mirrors a policy that originated with the National Wetlands Policy Forum in 1987 (Mitsch and Gosselink 1993), which strives to avoid and minimize wetland impacts wherever practicable and to compensate for unavoidable impacts through restoration of degraded wetlands (National Park Service 2001).

The U.S. Fish and Wildlife Service produces National Wetland Inventory (NWI) maps that provide information on the characteristics, extent, and status of wetlands and deep-water habitats (U.S. Fish and Wildlife Service 2003a). Maps that included Sequoia and Kings Canyon National Parks, California, were produced in 1996. This information is in the public domain and is important for planners, managers, and scientists. We used these maps because they provided the most readily available information on wetland types and their locations.

The NWI maps do not replace the accuracy of on-site wetland delineation, but they should provide meaningful data about the wetlands of an area. Our field surveys were not intended to characterize the parks' wetlands; rather, our purpose was to assess the accuracy of the NWI maps for Sequoia and Kings Canyon National Parks. We classified all sites on the basis of definitions and descriptions in Cowardin et al. (1979) and used NWI map codes (U.S. Fish and Wildlife Service 2003b).

Methods

We performed fieldwork during summer in 2000 and 2001. The work resulted in two basic data collection strategies: (1) field verification of a sample of NWI sites for identifying errors of commission (in this case where wetlands were misclassified or upland areas were classified as wetlands) and (2) sampling along transects for identifying errors of both omission and commission. We selected "verification sites" with the fullest range of NWI wetland taxa available and "transect sites" to represent the spatial extent and diversity of landscapes in the parks (fig. 1). The field crew, consisting of two biological science technicians, surveyed all wetlands encountered (mapped and unmapped) along selected transects.

The NWI maps show 23,091 wetland sites within Sequoia and Kings Canyon National Parks. The crew surveyed 900 wetland sites, which included 294 verification

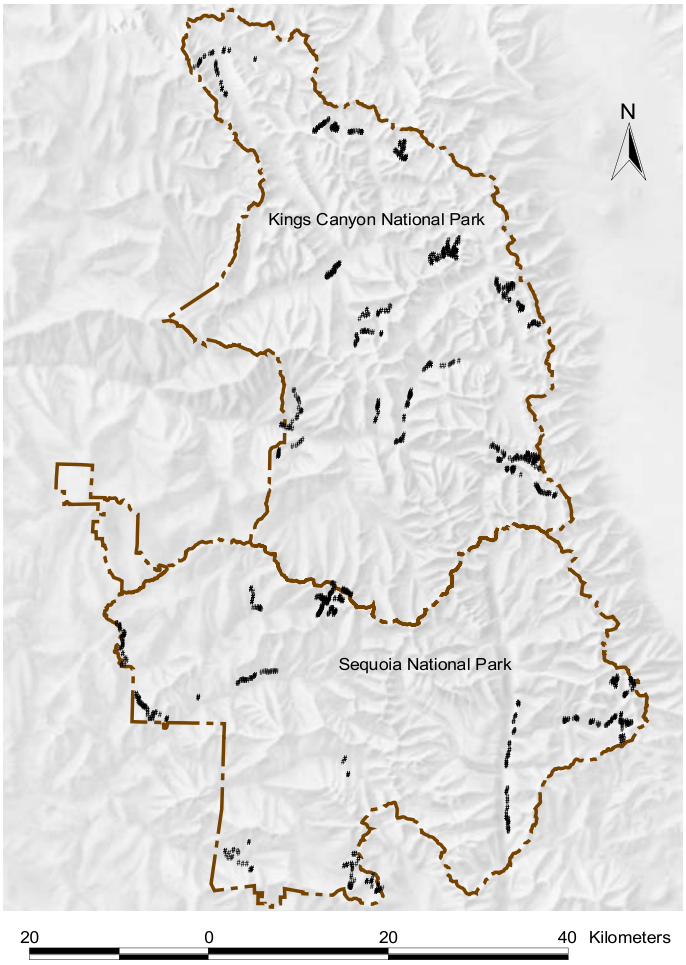

Figure 1. To assess the National Wetland Inventory maps, investigators selected validation sites that represented the fullest range of wetland taxa available, and surveyed transects representing the spatial extent and diversity of landscapes in Sequoia and Kings Canyon National Parks. Surveyed sites are marked in black on the figure.

sites, encounters with 596 sites along transects, and 10 incidental encounters of unclassified sites during validation. Of the 900 wetland sites examined, 620 were on the NWI maps. These 620 sites included all of the verification sites and 326 transect sites. All 620 sites were used for evaluating the accuracy of the points, lines, and polygons delineating wetlands on the digital GIS layer representing the NWI maps. Our classification scheme allowed for one taxon per site; therefore, crew members classified each of the 900 sites on the basis of the dominant taxon. Because some sites contained multiple wetland taxa, field investigators made 1,257 taxonomic determinations at the 900 sites.

The crew classified wetlands to subclass and estimated hydrologic regime. For each site they identified the location using Universal Transverse Mercator (UTM) coordinates, elevation, slope, aspect, adjacent substrate, average feature width, vegetation type, and predominant vegetation.

Results

Validation of NWI wetland sites

Of the 294 NWI wetland sites that the field crew validated, only one was an upland. On the NWI map, investigators had classified it as Palustrine Emergent Wetland (PEM, see table 1). This is an error of only 0.34% (3.4 per thousand) for misclassifying upland as wetland.

Few discrepancies occurred between the NWI maps and field surveys for the Lacustrine data (fig. 2). Putting subsystem differences aside (e.g., L1 vs. L2, see table 1), the field crew determined that 97% of the sites identified as Lacustrine on NWI maps were correct. They determined that 3% were Palustrine (PUB, see table 1).

Our survey found considerably more problems at the NWI Palustrine sites than at the Lacustrine sites. At the system level (see table 1), 6% of the Palustrine sites identified on NWI maps were not actually Palustrine. At the class level (see table 1), only 67% of the sites identified as Palustrine Emergent Wetland (PEM) were identified correctly (fig. 3). Twenty-six percent of the Palustrine Emergent Wetland were actually Palustrine Scrub-Shrub Wetland (PSS). Only 64% of the Palustrine Forested Wetland (PFO) were correct. Sites classified erroneously as Forested Wetland (PFO) were primarily meadows (PEM) or Scrub-Shrub Wetland (PSS). Sites classified as Palustrine Scrub-Shrub Wetland were correct 66% of the time. Twenty-two percent of the Palustrine Scrub-Shrub Wetland sites were meadows (PEM), and 8% were forested (PFO). In general, a two-thirds probability exists that sites identified as Emergent Wetland, Scrub-Shrub Wetland, or Forested Wetland on the NWI maps are correct, but there is a 96% likelihood of the site being one of these three. National Wetland Inventory maps incorrectly classified 55% of the Palustrine Unconsolidated Bottom (PUB) sites. Twelve percent were ponds, but either with Rock Bottom (PRB, 8%) or vegetated bottoms (PAB, 4%); 23% were lakes; 13% were meadows; and the remainder (7%) was Scrub-Shrub Wetland, Palustrine Unconsolidated

Table 1. Wetland classification terms used in text

System, subsystem, and class	Symbol	Example
Palustrine		**Pond or emergent vegetation**
Emergent Wetland	PEM	Wet meadow
Unconsolidated Bottom	PUB	Pond with mud/sand/cobble/gravel bottom
Scrub-Shrub Wetland	PSS	Willow stand
Forested Wetland	PFO	Alder or riparian forest
Aquatic Bed	PAB	Pond with vegetated bottom
Unconsolidated Shore	PUS	Pond shore of mud/sand/gravel/cobble
Rock Bottom	PRB	Pond with bedrock/boulder bottom
Lacustrine		**Lake**
Limnetic	L1	Lake area >2 m deep (deep open water)
Unconsolidated Bottom	L1UB	Lake margin with mud/sand/gravel/cobble bottom
Littoral	L2	Lake area <2 m deep (shallow, usually near shore)
Rocky Shore	L2RS	Lake shore of bedrock or boulders
Unconsolidated Bottom	L2UB	Lake with mud/sand/gravel/cobble bottom
Rock Bottom	L2RB	Lake with bedrock/boulder bottom
Aquatic Bed	L2AB	Lake with vegetated bottom
Riverine		**River or stream**
Upper Perennial	R3	High gradient, fast permanent flow
Unconsolidated Bottom	R3UB	Stream with mud/sand/gravel/cobble bottom
Rock Bottom	R3RB	Stream with bedrock/boulder bottom
Intermittent	R4	Seasonal flow
Streambed	R4SB	Any intermittent stream

Source: Cowardin et al. (1979) and U.S. Fish and Wildlife Service (2003b).

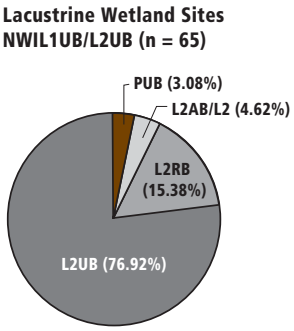

Figure 2. Few discrepancies occurred between NWI maps and field surveys for Lacustrine sites. Ninety-seven percent of the Lacustrine sites were correct. The remaining 3% were Palustrine (ponds).

Shore (PUS), or Upper Perennial (R3) stream. Twenty percent of the sites classified as Palustrine Unconsolidated Shore (PUS) were correct. Most sites were either Lacustrine Littoral Rocky Shore (L2RS, 40%) or Palustrine Emergent Wetland (40%).

The classification of Riverine systems on the NWI maps also had many problems (fig. 4). The crew found only half (51%) of the NWI Riverine sites actually to be Riverine. The remaining misclassified sites were actually Palustrine, primarily Scrub-Shrub Wetland (22%), meadow (PEM, 16%), and forested (PFO, 9%). Only 45% of the sites labeled Upper Perennial streams with Rock Bottom (R3RB) were correct (fig. 4). Eight percent were Upper Perennial streams with Unconsolidated Bottom (R3UB), 3% were Intermittent Streambed (R4SB), and the remainder was Palustrine (44%). The only Riverine site labeled as Unconsolidated Bottom was a meadow (PEM). Less than one-third (29%) of the sites labeled as Rocky Shore (L2RS) were re-classified correctly. The remaining misclassified sites were actually Riverine Rock Bottom (14%) or Palustrine (primarily PEM, 57%). Only 37% of the sites labeled on the NWI maps as Intermittent Streambed (R4SB) were correct. Six percent were Upper Perennial Rock Bottom (R3RB) and the others were Palustrine (57%).

Overall, 45% of the sites encountered on transect surveys were not on NWI maps.

Wetland transects

Overall, 45% of the sites encountered on transect surveys were not on NWI maps. This suggests that about half again as many wetlands and deep-water habitats may exist in the parks as are displayed on the NWI maps. Few (5%) of the omissions were found to be Lacustrine systems. Most omissions were Palustrine and Riverine (fig. 5, page 22).

Forty-two percent of surveyed Palustrine wetlands were not on the NWI maps. More than half of these were meadows (PEM, 55% of unmapped Palustrine wetlands). The remainder was primarily Scrub-Shrub Wetland (PSS, 21%) or forested (PFO, 20%). A few ponds (either PUB or PRB, 4%)

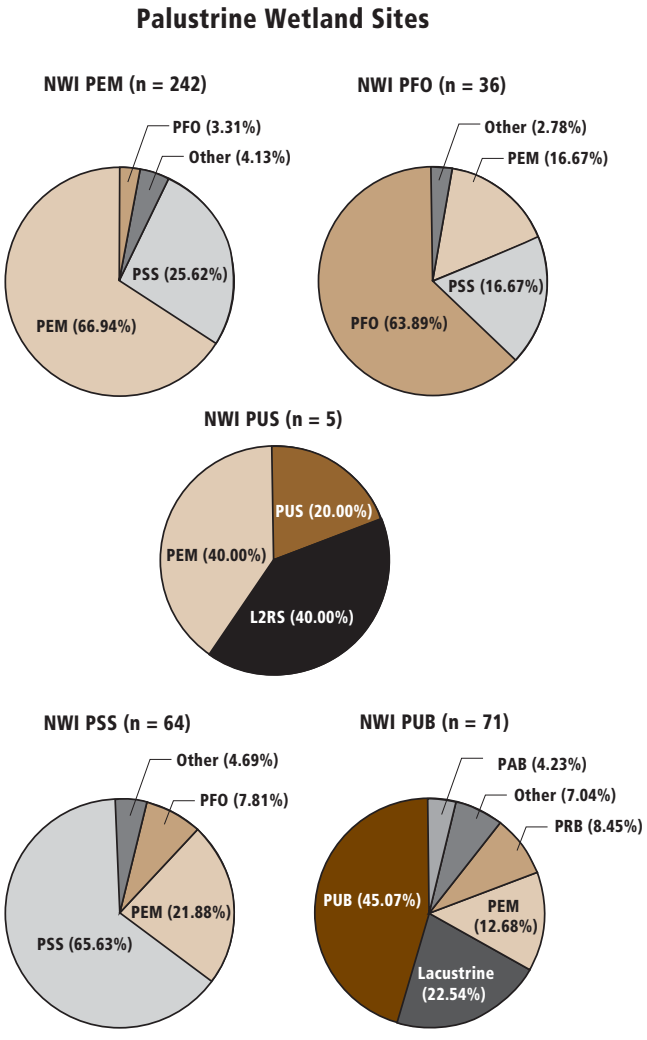

Figure 3. Field investigations revealed considerable problems with Palustrine sites shown on NWI maps. For example, of the 242 Palustrine Emergent Wetland (PEM) sites classified on the NWI maps, only 67% of the sites were classified correctly at the class level.

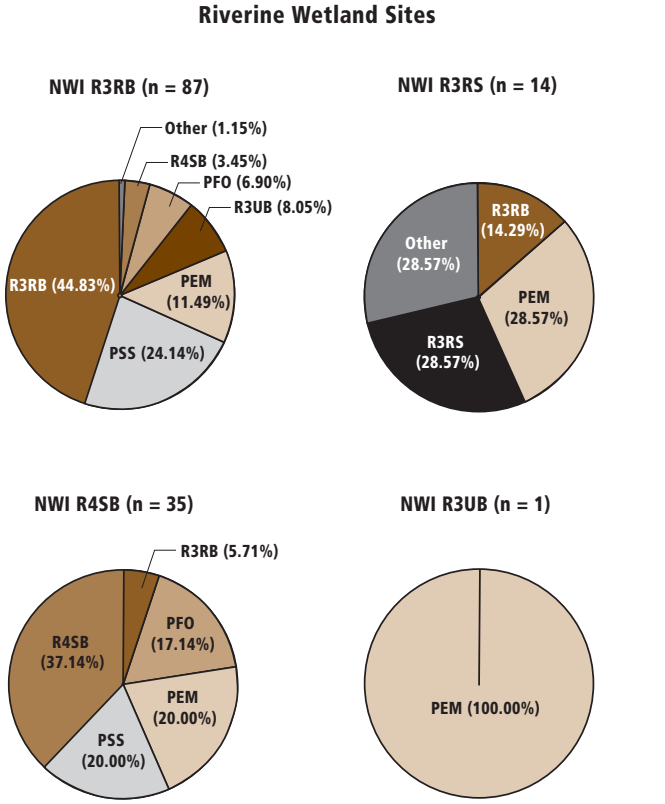

Figure 4. Field surveys revealed the greatest errors in classifying Riverine wetlands. Comparing all four Riverine classes combined, only half (51%) of the sites classified on the NWI maps were correct. The pie charts show what was actually observed in the field for each of the Riverine classes. For example, on the NWI maps used for the survey, Riverine Unconsolidated Bottom (R3RB) was correct about 45% of the time.

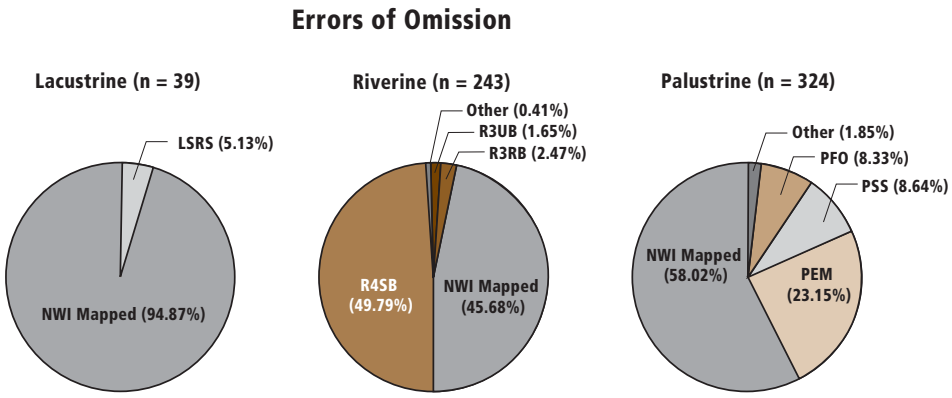

Figure 5. Surveys along wetland transects showed that about half again as many wetlands and deep-water habitats may exist in the parks as are displayed on the NWI maps. The pie charts show for each system the proportion of wetlands mapped during the National Wetlands Inventory compared to newly identified sites during field surveys. Most sites not included on NWI maps were Palustrine and Riverine.

and some Unconsolidated Shore (PUS, 1%) also occurred.

Wetlands in the Riverine system had the highest frequency of not occurring on NWI maps. Fifty-four percent of the Riverine wetlands surveyed were not on NWI maps. Ninety-two percent of these were Intermittent Streambed (R4SB), which are probably the most cryptic and ubiquitous of the Riverine classes. The remainder was Upper Perennial somewhat evenly distributed between Rock Bottom and Unconsolidated Bottom.

> Our findings are not necessarily applicable to other localities, and may have declining relevance outside the southern Sierra Nevada.

Water regime

The NWI maps include water regime in addition to wetland taxa. Water regime is a difficult parameter to estimate without long-term knowledge of a site. However, a site's water regime does have indicators: floristic community, fauna, current condition for time of year, soil, and high-water marks.

The NWI maps and field determinations concurred best for the wettest and one of the driest water regimes, with 81% agreement for "permanently flooded" sites (n = 208) and 56% agreement for "temporarily flooded" sites (n = 46). Of the other predominant water regimes, only 35% of the NWI sites labeled "seasonally flooded" matched field observations (n = 161). Many were "temporarily flooded" (20%) or "seasonally flooded/saturated" (16%). Only 17% of sites (n = 156) labeled as "saturated" actually were. Most "saturated" sites were "seasonally flooded/saturated" (22%), "temporarily flooded" (19%), or "seasonally flooded" (17%). The greatest disparity existed with sites labeled "semipermanently flooded" with only 11% agreement (n = 28). Most of them were "permanently flooded" (36%) or "seasonally flooded" (21%).

Discussion

The discrepancies between NWI maps and our field investigations need to be considered within the context of where, when, and how they were measured. Our findings are not necessarily applicable to other localities, and may have declining relevance outside the southern Sierra Nevada. Temporal change may have induced some errors. These NWI maps are based on aerial photography that was flown primarily in August 1985, 15 years before we initiated this assessment. Fires, floods, and succession could have caused some of the differences. Furthermore, our field crew had a distinct advantage over personnel working from 1:58,000-scale aerial photography. The NWI investigators classified the sites on the basis of what taxonomic attributes were available to them on film, which were calibrated with some field investigations. Members of our field crew saw and measured features that probably were not visible on the photographs (fig. 6), particularly where canopy obscures the sites. Some errors may reflect differences in the interpretation of definitions in Cowardin et al. (1979). However, inconsistencies should be minimal because the definitions are very explicit.

Although we found considerable discrepancies between the NWI maps and our field observations, I continue to find the NWI maps useful. For example, where wetlands were indicated, they typically existed, and the taxonomy was generally correct. The NWI maps provide a quick representation of the types and distribution of wetlands to be expected.

Figure 6. Investigators on the ground often observed far more complexity than was evident on the NWI map. Here a small Riverine unit (R3UB) flows through a wet meadow (PEM) after emerging from a stand of willows (PSS). This Riverine unit was not on the NWI map. NPS PHOTO

Recommendations

1. Users of the NWI maps should trust that the wetlands and deep-water habitats shown probably exist. However, they should expect that the maps may have omitted nearly half as many additional wetlands.
2. Users should be suspicious of the accuracy of taxonomy on the maps. However, the Lacustrine sites are the most trustworthy.
3. For applications where accuracy is critical, such as planning of research or monitoring projects or preparing for Section 404 compliance of the Clean Water Act, on-site delineation or evaluation is essential. The maps should be used only as an indicator of what to expect.
4. Managers wishing more detailed information about this survey should see Werner (2003).

Acknowledgments

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About the author

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"Information Crossfile" continued from page 12

4. Avoid development near existing observatories, and apply rigid controls on outdoor lighting when development is unavoidable. *—K. KellerLynn*

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Reports Available Online

Two new reports on recently completed inventories are posted on the Web site for the Northeast Region: "Comprehensive inventory of birds and mammals at Fort Necessity National Battlefield and Friendship Hill National Historic Site" and "Inventory of intertidal habitat: Boston Harbor Islands, a national park area." These can be viewed at and downloaded from http://www.nps.gov/nero/science. *—B. Blumberg*